Preliminary Note on the Life-Period of the Bulb Mite, *Rhizoglyphus echinopus*.

By

Nobumasa Yagi.

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Introduction.

For the past half century the bulb-mite has been one of the most widely distributed pests of great economic importance for horticulture and agriculture.

Fumouze and Robin[1] were the first to describe the species under consideration in the year 1868, naming it *Tyroglyphus echinopus*, before this Boisduval[2] called the mite with the unscientific name of *Acarus hyacinthi* (1867). In the year 1869 Claparéde[3] described this as *Hypopus dugardini*, having thought that there was dimorphism among the males; one form of which is in reality the female and the other its hypopus stage as was pointed out by Michael[4] (1885).

Reuter[5] (1902) unified these names under *Rhizoglyphus echinopus* (Fum. et Robin). So far as I know, the life-cycle of this mite has never been recorded by any author, and the present paper deals principally with the external morphology of each stage which are found during the summer.

Michael considered the occurrence of hypopus as accidental. But I happened to come across a case, which may contradict the above statement, and in which its production may be due to scanty food. Two hypopi were found in a vial in which a male and a female had been confined on a little narcissus bulb and wet sand for forty-eight days.

I. Method.

A male and female were placed on the cut surface of a narcissus bulb, the old outer scales of which had been peeled off and then put into moist sand spread in Petri-dishes.

1) Jour. Anat. Physiol. Paris., T. 5, P. 287—304, Pls. 20—21, 1868.
2) Entmologie horticole, P. 86, 1867.
3) Zeit. f. Wiss. Zool., Bd. 18, S. 506, 1869.
4) Jour. R. Mic. Soc. Lond., 2 ser., Vol. 5, P. 26, 1885.
5) Med. Fauna. Flora fennica, Bd. 27, S. 123, 1902.

The complete record of each stage arising from the original pair has been taken.

II. The Larva.

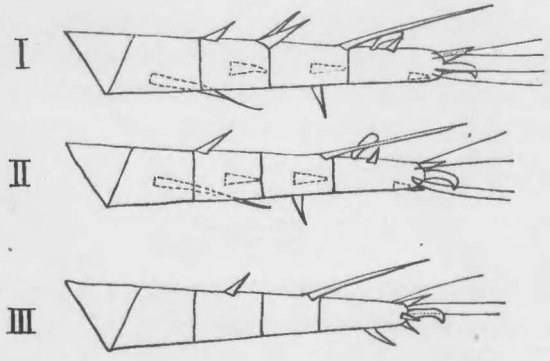
(Pl. VII, Fig. 3)

The larva just hatched from the egg is white and transparent measuring 0.67 mm. in length. It has three pairs of legs, of which the first two are on the prosomite and the third on the metasomite. On the ventral surface between the first and second pairs is a pair of respiratory processes (Pl. VII, Fig. 11), 0.055 mm. in length 0.15 mm. in width. These have been thought by former authors to be functional only before hatching. But judging from its presence until moulting, its function may be somewhat different. At the base of each tarsus of the first and second legs is a cudgel shaped sensory hair, which is slightly bent downwards. The number and position of hairs in each segment of three legs are shown in the following table and diagrams.

Table 1.

Number of hairs on each segment of larval legs.

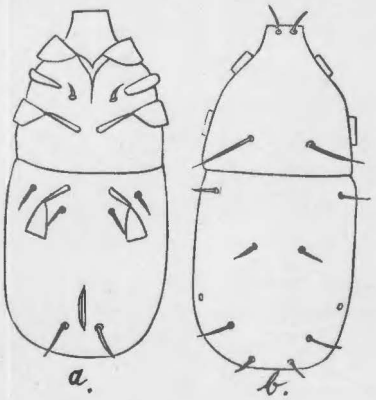
Seg. / Leg	Cox.	Troc.	Fem.	Tib.	Tar.
I	0	1	4	3	7
II	0	1	2	3	7
III	0	0	1	1	7



Text-fig. 1. Diagrams of the left legs of larva, anterior view.

Of the seven tarsal hairs on each leg, 4 on the first and second legs, 3 on the third legs are very fine, like strings. On the prosomite are three pairs of hairs, two pairs of which being situated dorsally, and one pair ven-

trally. On the metasomite four pairs of hairs are found on the dorsal surface, and a pair on the ventral surface, as shown in the figures (Text-fig. 2). At this stage one can detect neither the external genital organs nor the suckers.



Text-fig. 2. Larva seen from the ventral side (a), and that from the dorsal side (b), showing the position of hairs.

The contents of the "expulsory vesicle" of Michael do not present so vivid a color as in the subsequent two stages when they can be seen through the skin. The mouth parts have almost the same structure as in the other two stages (Pl. VII, Fig. 10).

III. The First Pupa.

(Pl. VII, Fig. 4)

The nymph formed in the immobile larval body is seen through the skin. Its legs are bent and folded over the ventral surface, and the first two pairs can be distinctly seen from dorsal side. Judging from the number of hairs shown in the text-figure 3, it seems that the fourth legs which come out at this stage are formed behind the third.

IV. The Nymph.

(Pl. VII, Fig. 5)

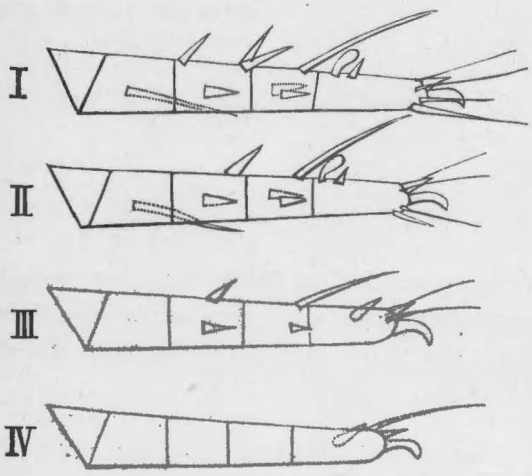
The nymph is as white as ever, measuring from 0.87 mm. to 1.15 mm. in length. Each of the pair of legs on the prosomite has respectively six hairs on the tarsus, one hair being lost at the moulting. The number of hairs on the tarsus of the third leg has been reduced to four.

The reader may get a clearer idea of the above by comparing the diagrams of larval legs (P. 350) with the following one.

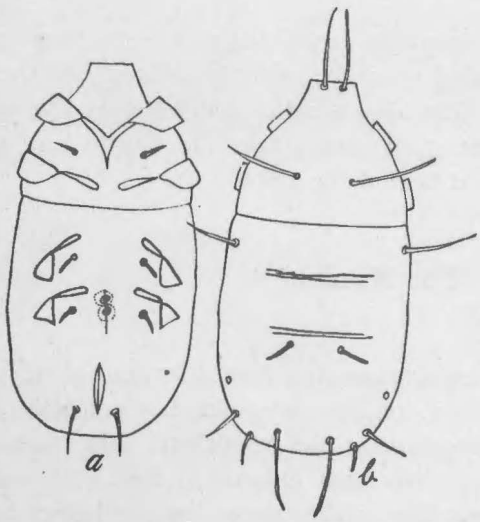
Table 2.

Number of hairs on each segment of Nymphal legs.

Leg \ Seg.	Cox.	Troc.	Fem.	Tib.	Tar.
I	0	1	4	3	6
II	0	1	2	3	6
III	0	0	2	2	4
IV	0	0	0	0	3



Text-fig. 3. Diagrams of the left legs of Nymph, anterior view.



Text-fig. 4. Nymph seen from the ventral side (a), and that from the dorsal side (b), showing the position of hairs.

The body hairs on the prosomite are of the same number as those of the larva, while the number of those on the metasomite is increased by a pair dorsally near the posterior end.

Ventrally there is no difference between this and the preceding stage. In addition to the suture between the prosomite and the metasomite, there appear dorsally two transverse grooves, one between the third and fourth legs, and the other a little anterior to the second series of hairs. The "expulsory vesicle" (Pl. VII, Fig. 12) varies in color from white to yellowish, and it is filled up with an oily substance.

The sexual aparture is not yet seen. Two genital suckers make their appearance at this stage, being arranged longitudinally (Pl. VII, Fig. 13). The sex of the individium is either incapable of being detected or it has not yet been detected.

V. The Second Pupa.

(Pl. VII, Fig. 6)

In the immobile nymph, the adult can be observed through the skin, being covered by two coverings,—the white intermediate and the new chitinous integments. The four pairs of legs are not distinctly seen from without at this stage, for they are white and the adult is formed deeply in the puparium. In the abdomen of this enclosed adult, appears a white opaque mass, which probably represents the seat of formation of the genital organs.

VI. The Adult.

On entering in this stage a distinct sexual difference may be seen from outside and also a dimorphism among the males, the normal and the heteromorph.

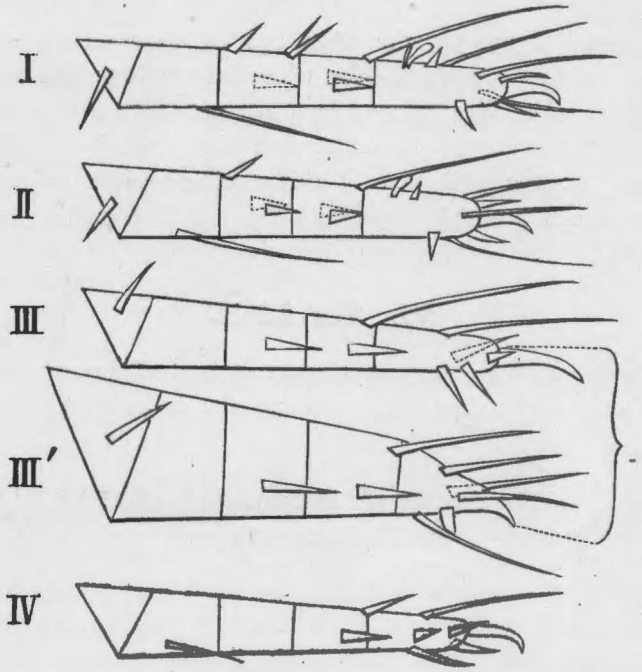
(a) The Normal and Heteromorphous Males.

(Pl. VII, Fig. 7 and Fig. 8)

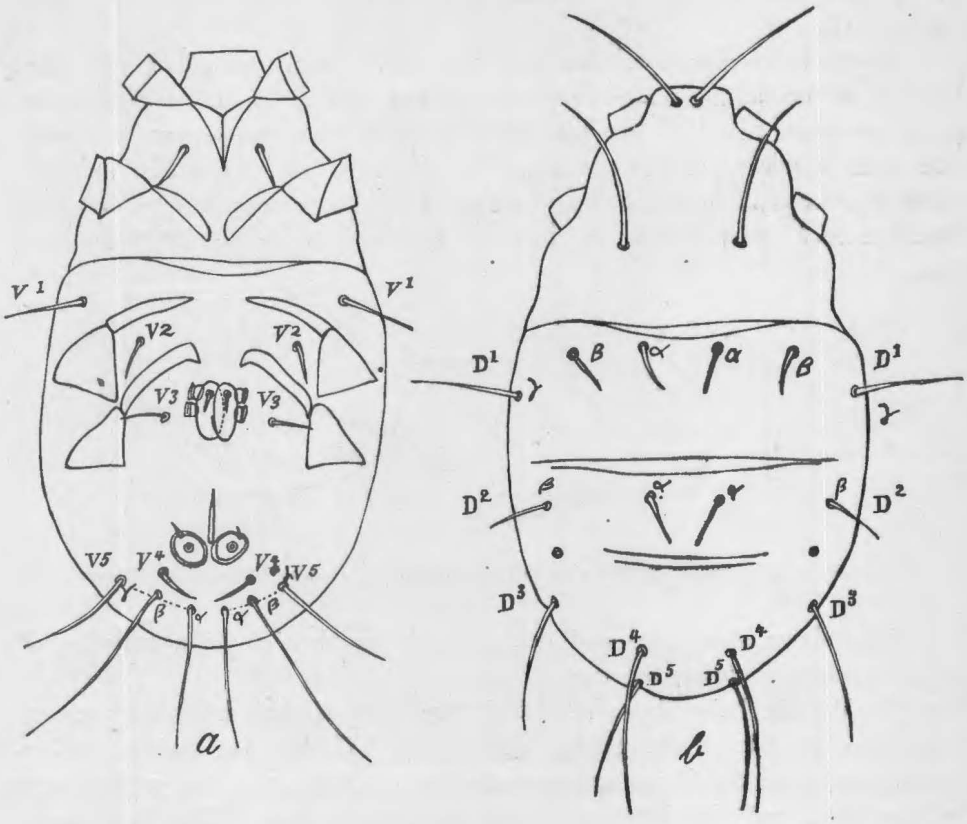
The male is pale yellowish white, the head and all the legs purplish. The entire length of the body is from 1.24 mm. to 1.44 mm. The prosomite of the male is wider than that of the female, bearing very long hairs in the same position as in the nymph. On the metasomite are ten hairs both on the dorsal and the ventral side. The last two pairs on the dorsal and one pair on the ventral are shorter and longer than others, projecting caudally as the text-figure shows. The sexual opening (Pl. VII, Fig. 14) between the fourth legs is coverd by two oblong chitinous flaps, each provided with a short stout hair near the anterior edge. On each side of genital flaps respectively are two suckers, and another pair of large conical suckers near the anus, each bearing a short hair on its anterior ridge. The

hairs on the legs are stouter and longer than those of the female and of younger individuals. On each first leg a fine accessory sensehair is added near the original one. A hair makes its appearance at the coxal segment of each of the three pairs (I—III) of legs. The claw of the third leg is the longest and has the lean curvature as compared with the others (Text-fig. 5, III).

In the heteromorphous male the third legs are thickened twice as much as that of the normal; the claw also greatly widens at its base and the joint between the claw and the tarsus is obliterated, the former acquiring the same purplish color as the latter (Text – fig. 5, III′). The fact that the third legs become stouter in the heteromorphous male may have an adaptive significance to clasp the dorsal side of the abdomen of the opposite sex, when mating.



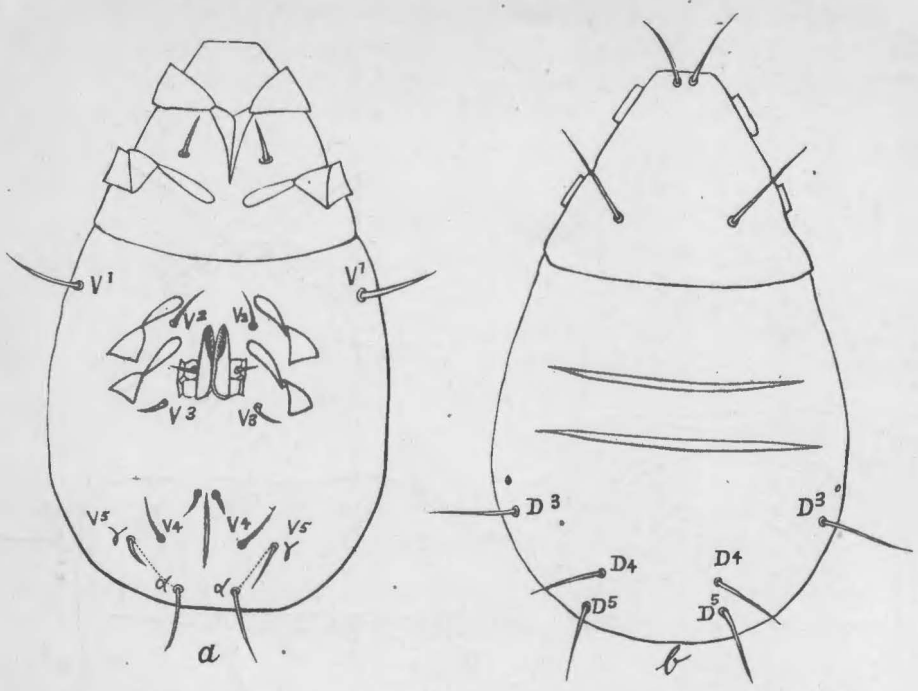
Text-fig. 5. Diagrams of four left legs in the male, anterior view. III, normal, III′, heteromorphous third leg.



Text-fig. 6. The male, ventral view (a), dorsal view (b), showing the position of hairs; dorsal hairs are marked D, the ventral ones V, the longitudinal series are indicated in the Greek alphabet.

(b) **The Female.** (Pl. VII, Fig. 9)

The body is pale yellowish white and piriform, measuring from 1.56 mm. to 1.76 mm. in length, the head and legs are purplish as in the male. The body hairs are shorter and more delicate than those in the male. Those hairs of the male as indicated in the accompanying diagrams, D^1, D^2, β of V^5, are not found in the female.



Text-fig. 7. The female, ventral view (a), dorsal view (b), showing the position of hairs.

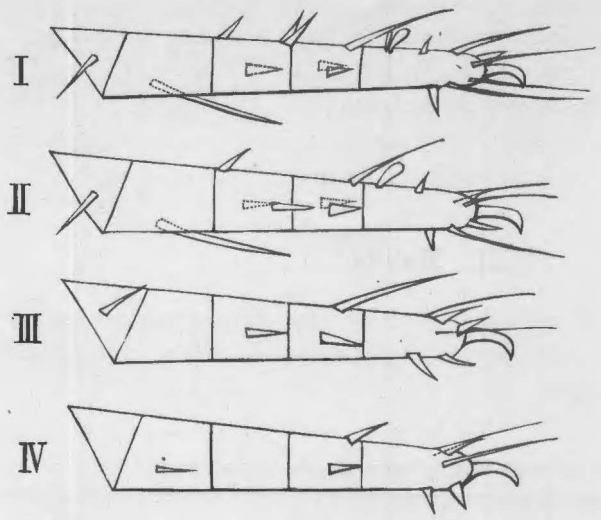
The above shortening and decreasing in number of hairs may be of some advantage during the time of pairing.

Besides the hairs above described, two pairs of short hairs are present, one on each side of the genital opening (Pl. VII, Fig. 15) and the other above the anus, the former corresponding to the hairs near the genital flaps of the male, and the latter to those near the suckers. The "expulsory vesicle" has the same yellowish color in both sexes. The two ventral sutures, one between the third and fourth legs, and the other posterior to D^2, are also the same in both sexes. The same number of leg hairs are found in the female as in the male.

Table 3.

Number of hairs on each segment of legs, male and female.

Leg \ Seg.	Cox.	Troc.	Fem.	Tib.	Tar.
I	1	1	4	3	8
II	1	1	3	3	7
III	1	0	1	2	5
IV	0	1	0	2	5



Text-fig. 8. Diagrams of the female left legs, anterior view.

VII. Duration of Life.

The duration of a generation of this mite is affected greatly by temperature: in May one cycle takes 20 or 24 days, while in June 15 days, and in August 11 or 12 days. The difference is due to the length of embryonic development, which varies from 1 day (in August) to 10 days (in June), the rest of the life extends from 10 to 14 days as is shown in my six breeding experiments:

Table 4.

Periods of each stage.

	I (May, 1916)	II (May, 1916)	III (June, 1916)	IV (June, 1916)	V (Aug., 1917)	VI (Aug., 1917)
No. of days between copulation and oviposition.	6 days	9 days	3 days	1 day		
No. of days between oviposition and hatching.	9 „	10 „	4 „	4 „	1 day	1 day
Larva stage.	3 „	3 „	1 „	3 „	2 „	3 „
1st Pupa stage.	0.5 „	1 „	1 „	1 „	2 „	1 „
Nymph stage.	3 „	4 „	2 „	2 „	1 „	1 „
2nd Pupa stage.	0.5 „	1 „	1 „	2 „	3 „	1 „
Adult stage up to oviposition.	3 „	1 „	3 „	2 „	2 „	5 „
Length of a generation.	24 „	20 „	15 „	15 „	11 „	12 „

My breeding experiments carried out during December and January turned out to be a failure since the bulbs in the dishes were frozen. In the vine-roots kept in the glass house in the orchard, however, I could find in the same months all the stages of the mite.

From what has been stated, it may not be amiss to presume that in Sanyodo in Honsiu the mite at least achieves 10 generations in a year.

VIII. Habits.

Egg:—The number of eggs deposited by one female varies from 9 to 56, and 1 to 32 per dium, the egg is singly dropped on the surface of the bulb used for the experiments.

Table 5.

The number of eggs laid after a single copulation.

	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	Total
I	4	10	2	0	0	0	0	0	16
II	0	2	0	0	0	0	7	0	9
III	0	0	3	32	0	0	0	0	35
IV	0	0	0	1	10	0	0	0	11
V	0	0	8	8	9	0	0	0	25
VI	0	3	29	0	24	0	0	0	56
VII	0	0	1	9	4	3	10	0	27
VIII	0	8	8	9	21	0	0	0	46

The egg (Pl. VII, Fig. 1) is white and transparent, and is surrounded by a gelatinous covering. As the embryo (Pl. VII, Fig. 2) develops the color changes into milky white.

Larva:—It moves slowly and bores through the bulb or the root tissue of grape-vines. It is negatively phototactic.

Whereas all stages do not differ in feeding habits, negative phototaxis is more pronounced in the larval stage.

First pupa:—It is always found in dark places thrusting its head into depression formed in injured tissue or between the scales of the bulb.

Nymph:—It sucks the plant juice with their chelicerae as in the other stage.

Second pupa:—It is also found in places similar to the first one.

Adult:—The first copulation takes place 2 or 8 hours after having reached maturity. Egg laying begins on the day of pairing. The adult female continues to live about 2 to 4 weeks in the summer, while the male

has a shorter life (the one male which I kept for study died 10 days after maturity).

When pairing takes place, the male finds its seat on the metasomite of the female seizing it with his two posterior pairs of legs.

IX. Relation of the Mite to Other Organisms.

In the root of the grape-vine, *Phylloxera* larvae are found mixing invariably with the mite. Other mites, *Gamasus* and *Tydius*, were captured from the same root with this mite.

It is not likely that the mite can pierce into such a hard tissue as vine-roots with the same ease as bulbs, unless they have already been attacked by *Pylloxera* or other organisms. Sometimes the mites are found being killed by hyphae of *Fusarium*. Sometimes tiny Nematodes are found on their dorsal surface. The transmission of spores of injurious fungi to the tissues which have been injured by the mite may be accomplished through these mites.

X. Host Plants.

Host plants of this mite hitherto reported are as follows:

The tulip[1], hyacinth[2], euchalis[3], amaryllis[4], lily[5], Bermuda lily[6], dahlia[7], potato[8], garlic[9], wheat[10], rye[11], barley[12], *Centaurea jacea*[13], *Trapogon pratense*[14], *Ithyphallus impudicus*[15], orchid[16], and grape-vines[17].

The last mentioned plant is the chief host in the glass house of our Institute. To the above list I may add Canna and tree peony (*Paeonia moutan*).

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1. 2. 3. 4. 5) Boisduval, Ent. hort., P. 86, 1867.
6) Woods, U. S. Dept. Agr., Div. Veget. Physiol. Pathol., Bull. 14, PP. 7—15, 1897.
7. 8) Claparéde, Zeit. f. Wiss. Zool, Bd. 18, S. 506, 1869.
9) Carpenter, Injurious Insects...in Irland during 1903, PP. 258—260.
10. 11. 12. 13. 14) Reuter, Zeit. f. Pflanz. Krankh., Bd. 12, S. 326, 1902.
15) Istvanfy, „ „ „ „ Bd. 14, S, 300—301, 1904.
16) Banks, Proc. U. S. Nat. Mus., Vol. 28. PP. 84—85, 1904.
17) Mangin et Viala, Boll. Ent. Agr., T. 7, PP. 245—249, 1900.

Summary.

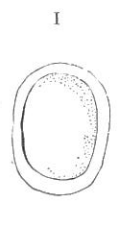
1) The bulb mite (*Rhizoglyphus echinopus*) moults twice in both sexes. External sexual differences appear in the adult.

2) The span of one generation is about 10 days in August, 15 days in July, and 20 days in June.

3) Difference of the length of life depends chiefly upon temperature, which remarkably affects the embryonic development

4) Both Canna and tree peony (*Paeonia moutan*) are found to be the host of this mite.

PLATE VII.



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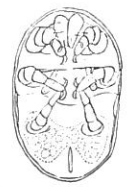

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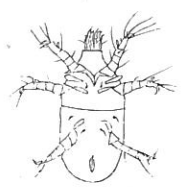

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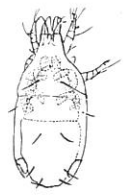

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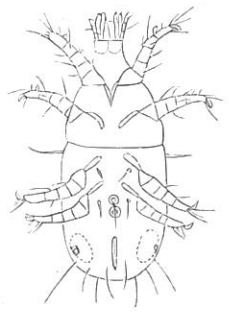

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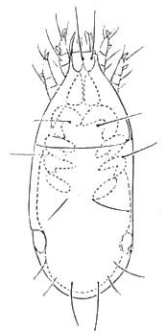

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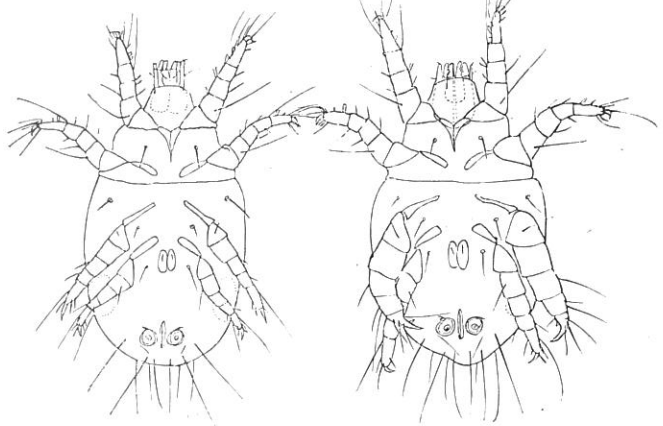

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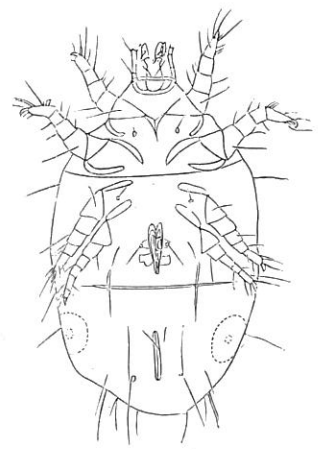

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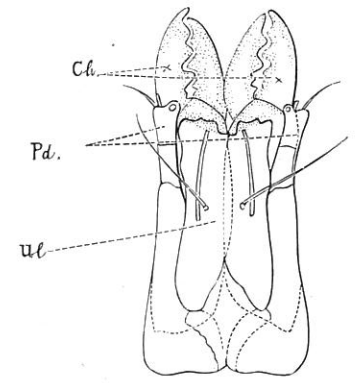

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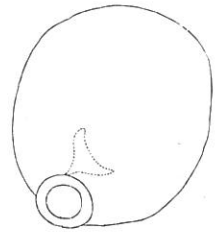

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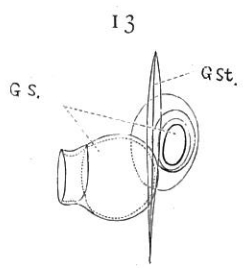

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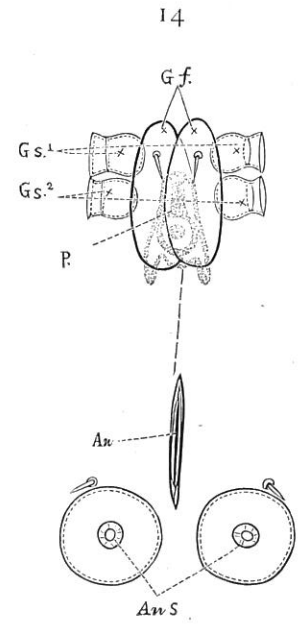

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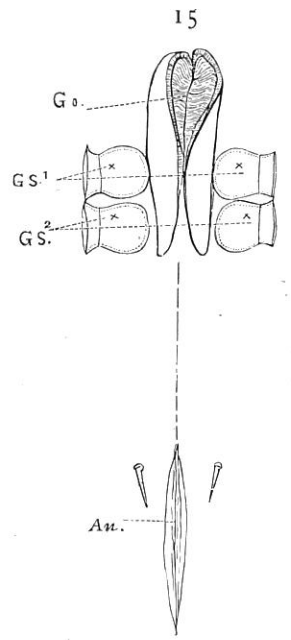

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Explanation of Figures.

Fig. 1 Egg. (×28).
Fig. 2 Embryo, completed in egg shell, ventral view. (×54).
Fig. 3 Larva, ventral view. (×28).
Fig. 4 First pupa, dorsal view. (×28).
Fig. 5 Nymph, ventral view. (×28).
Fig. 6 Second pupa, dorsal view. (×28).
Fig. 7 Adult normal male, ventral view. (×28).
Fig. 8 Adult heteromorphous male, ventral view. (×28).
Fig. 9 Adult female, ventral view. (×28).
Fig. 10 Mouth part, ventral view. (×80). Ch., Chelicera, Pd. Pedipalp, Ul, Under lip.
Fig. 11 Respiratory process of larva. (×340).
Fig. 12 "Expulsory vesicle" of nymph, greatly magnified.
Fig. 13 Genital sucker of nymph. GS., Genital sucker; Gst., Genital suture.
Fig. 14 Genital organ and anus of adult male, Gf., Genital flaps, GS¹, GS²., Genital sucker; P., Penis; An., Anus; Ans., Anal sucker.
Fig. 15 Do. of female, Go., Genital aperture, GS¹, GS², Genital sucker; An., Anus.

[N. Yagi del.]